Space Weather Technical Forecast

Issued on Sunday, 30 January 2022 at 12:44 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Slight chance G1/Minor Geomagnetic Storm day 1 (30th). Chance of further Moderate flares/R1-R2 Radio Blackouts. Potential for an Earth-directed CME after recent M1 flare – ongoing analysis.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate through the last 24 hours, with frequent C-class flare activity. Most of the flares originated from the large sunspot group AR2936 (Ehi/Beta-Gamma) in the northeast quadrant, approaching centre disc, and also an active region just rotating onto the southeast limb. The largest flare observed was an M1 at 29/2332UTC from AR2936, which produced an asymmetrical full halo coronal mass ejection (CME), visible in LASCO C2 imagery at 29/2336UTC, which could be Earth-directed - pending analysis.

There are currently three other numbered sunspot regions on the visible disc. AR2934 (Hsx/Alpha) in the southwest remains unchanged. AR2937 has now decayed. AR2935 (Bxo/Beta) in the northwest has seen some weak growth in its leading spots. AR2938 (Axx/Alpha) in the northeast has shown some very weak small spot re-emergence.

Meanwhile, a newly numbered sunspot region (AR2939 Hsx/Alpha) has emerged onto the southeast limb, and another region is also emerging onto the northeast limb.

No other Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: The solar wind, as observed at L1 started the period at 500km/s, slowly rising to a peak of around 550km/s into the UTC day, but have since slowly declined to slightly elevated levels, near 460km/s. The density has been predominantly at average levels. The total field strength (IMF) Bt, was mostly weak between 4-6nT, and is currently steady. The north-south component, Bz, remained weak and variable ranging between +6nT and -6nT. Phi angle was generally positive (away from the Sun), but with some brief negative fluctuations at the start of the period. Geomagnetic Activity was mostly Quiet to Unsettled (Kp 1-3), with an Active interval 29/1200-1500UTC.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) measured at GOES 16 was at background levels. The high energy electron flux (greater than 2MeV), was at background to moderate levels, peaking at 506 pfu at 29/1415 UTC. The associated electron fluence was below the Active threshold (1e8 integrated flux), with 1.13e7 recorded at 30/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate solar activity is expected through the period, with a chance of further isolated M-class flares, and a slight chance of X-class flares. These again most likely from AR2936, and an active region beginning to rotate onto the southeast limb, with a further region emerging onto the northeast horizon.

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Solar Wind / Geomagnetic Activity: A CME from 26 Jan could just give a weak Earth-directed glance on day 1 (30 Jan), although confidence is low. Otherwise, slightly elevated solar winds at first on day 1 (30th) are likely to gradually trend downwards towards background through the rest of the period, as the current high speed stream influence wanes. A further slight enhancement is possible from later on day 3 (01 Feb) from coronal hole 48.

Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3) with a chance of isolated Active intervals (Kp 4) and a slight chance of G1/Minor Storm (Kp 5) interval on day 1 (30th Jan). Thereafter, becoming generally Quiet to Unsettled, perhaps with a chance of isolated Active intervals from later day 3 (01 Feb). However, pending analysis of the CME from the M1 flare, there could be an Earth-directed component, which may result in further enhancement of geomagnetic activity, probably later in the period.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is forecast to most likely remain at background levels, however probabilities increase slightly through the period as AR2936 transits west. The high energy electron flux (greater than 2MeV) is expected to remain at predominantly background to moderate levels, but with an increasing chance of high levels being reached at the peak of the diurnal cycles, especially during days 3 and 4 (01 and 02 Feb). The associated 24hr fluence is expected to remain below the Active threshold, despite an increasing trend.

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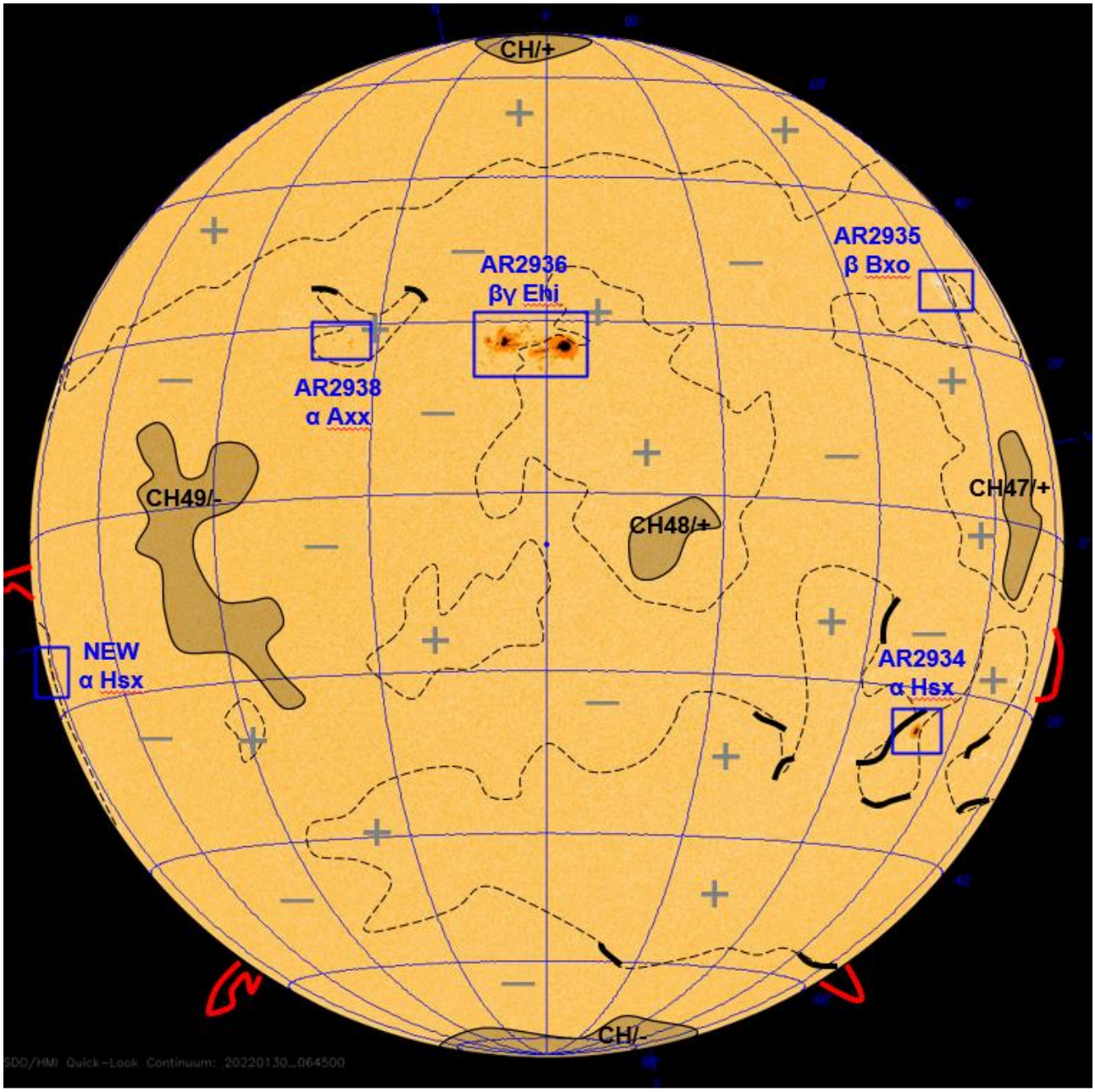
Figure 1. Solar Analysis Valid 30/0645UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A filament eruption at 26/1945 UTC, from near AR2934 generated a CME which could just give a weak Earth-directed glance on day 1 (30 Jan), although confidence is low.

Otherwise, slightly elevated solar winds at first on day 1 (30th) are likely to gradually trend lower to background levels during the rest of the period, as the current high speed stream influence wanes. A further slight enhancement is possible from later on day 3 (01 Feb) from coronal hole 48.

Geomagnetic activity is expected to be Quiet to Unsettled (Kp 1-3) with a chance of isolated Active intervals (Kp 4) and a slight chance of G1/Minor Storm (Kp 5) intervals on day 1 (30th Jan). Thereafter, becoming generally Quiet to Unsettled, perhaps with a chance of isolated Active intervals from later day 3 (01 Feb). However, pending the analysis of the CME from the M1 flare originating from AR2936, geomagnetic activity may become further enhanced, probably later in the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	15	5	10	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
27/0501	Partial	Filament	S23 W012	411	30/1200UTC	Low cofidence of any impacts

Figure 2: An M1 flare originating from AR2936 produced an asymmetrical full halo coronal mass ejection (CME), which can be seen in available coronagraph imagery (see SDO and STEREO-An images below). Potential for Earth-directed component – pending analysis in ENLIL.

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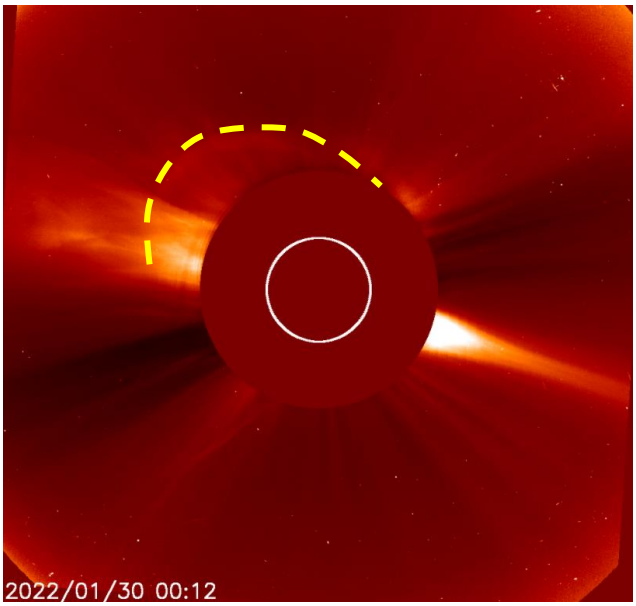

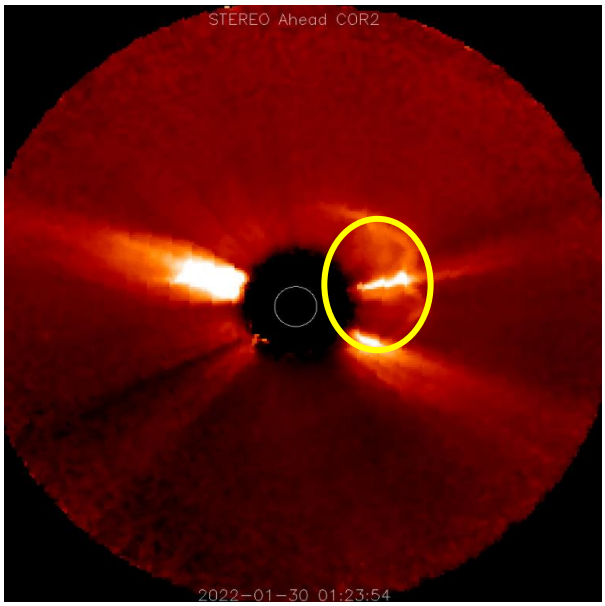

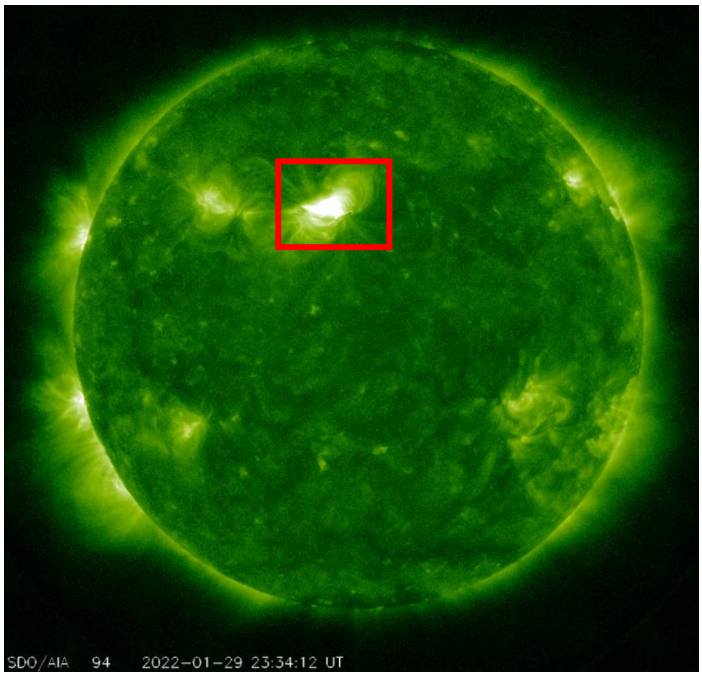

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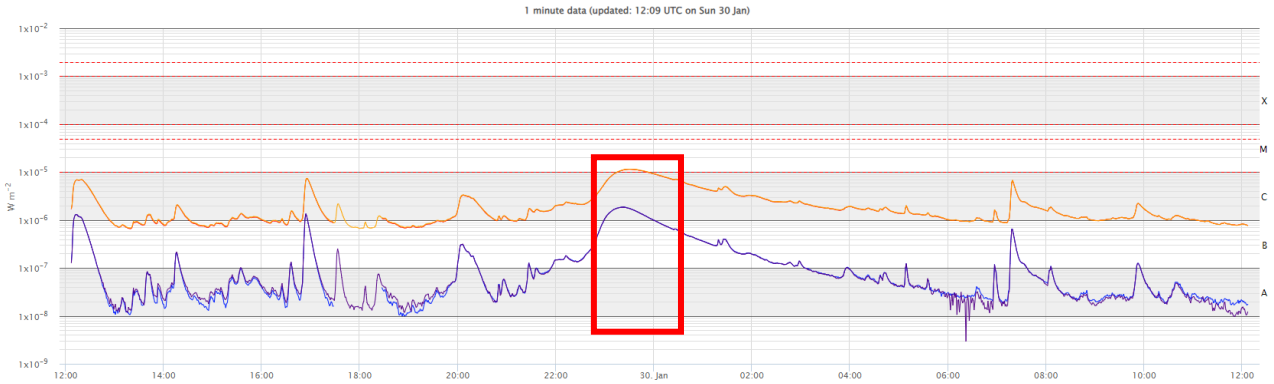
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate through the last 24 hours, also with frequent C-class flare activity. Most of the flares originated from AR2936 in the northeast quadrant, approaching centre disc, and also an active region just beginning to rotate onto southeast limb. The largest flare observed was a M1 at 29/2330UTC from AR2936. This produced a CME, which is currently being analysed at sight of the latest coronagraph imagery. However, given the location of AR2936 and the M1 flare, this is likely to have an Earth-directed component - pending analysis.

There are currently four numbered sunspot regions on the visible disc. AR2936 remains the largest and most complex (Ehi/Beta-Gamma), with ongoing evolution in the intermediate spots, and the large lead spot becoming more symmetric. AR2934 (Hsx/Alpha) in the southwest remains unchanged. AR2937 has now decayed. AR2935 (Bxo/Beta) in the northwest has seen some weak growth in its leading spots. AR2938 (Axx/Alpha) in the northeast has shown some very weak small spot re-emergence.

A new active region is just beginning to emerge around the southeast horizon, which has just been numbered AR2939. Another bright flux region on STEREO-A imagery is also close to the northeast horizon, which will continue to be monitored as its rotates around onto the disc.
Low to moderate solar activity is expected through the period, with a chance of further isolated M-class flares, and a slight chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	40	40	40	40
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: GOES X-Ray Flux – showing a long duration M1 flare originating from AR2936, which produced a CME – as mentioned in the above section.



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux, as measured by GOES-16 is at background levels. No solar radiation storms are likely in the period, however probabilities increase slightly through the period as AR2936 transits west.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	2	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) as observed by GOES-16 at GEO, was at background to moderate levels, peaking at 506 pfu at 29/1415 UTC. The high energy electron flux is expected to remain at predominantly background to moderate levels, but with an increasing chance of high levels being reached at the peak of the diurnal cycles, especially towards the end of the four day period. However, pending the analysis of the CME from the M1 flare originating from AR2936, this may have an impact the high energy electron forecast, probably later in the period.

With only a limited flux response anticipated from either fast wind enhancement, the associated 24hr fluence is expected to remain below the Active (1e8 integrated pfu) level despite an increasing trend. The Met Office REFM output supports fluence levels remaining below the Active period, and this is considered to be good guidance at this stage.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	20	30	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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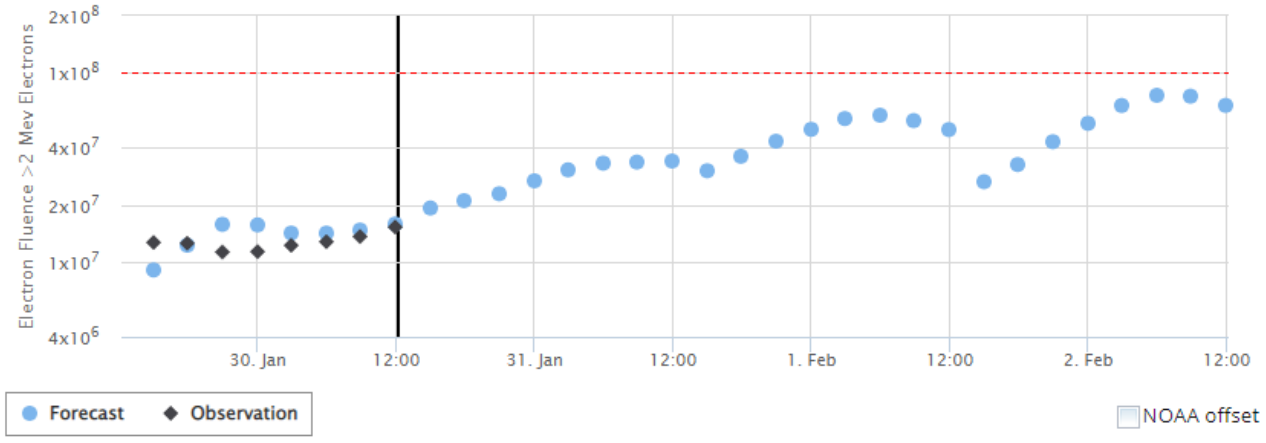
Figure 4: Met Office REFM electron fluence observations and forecast – trending upwards later in the period.



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